S I M P S O N E L E C T R I C C O M P A N Y

$1.00

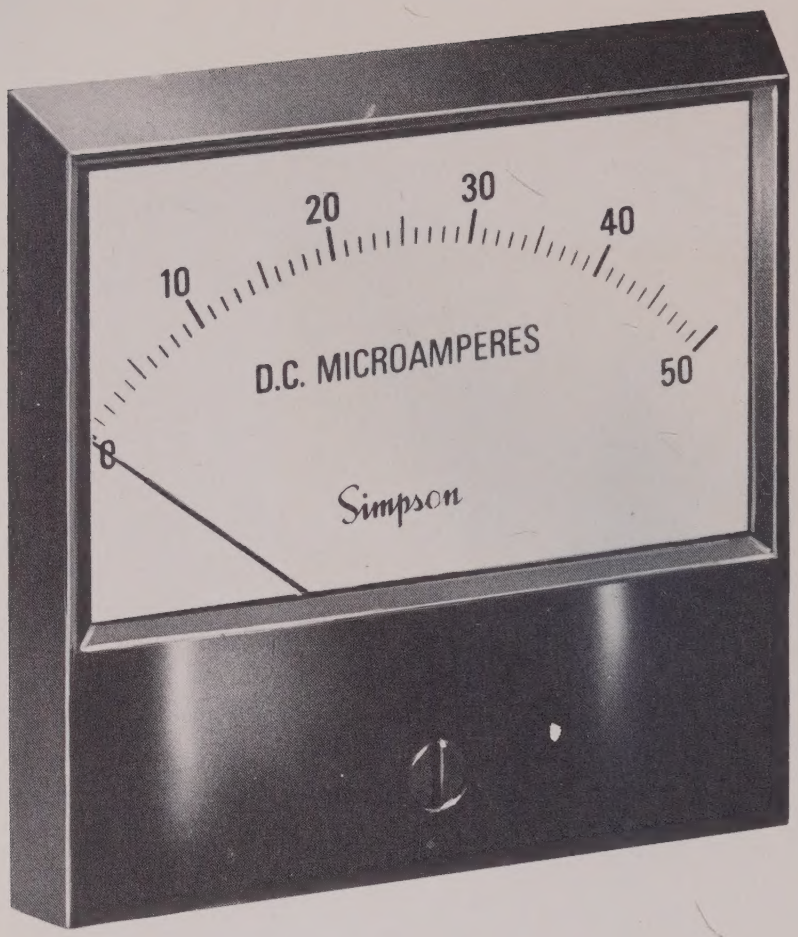
6C90

Simpson
INSTRUMENTATION PRODUCTS

INSTRUMENTATION MANUAL
MODEL 2701
DIGITAL MULTIMETER

SIMPSON ELECTRIC COMPANY 5200 WEST KINZIE CHICAGO ILLINOIS 60644 (312) 379-1121

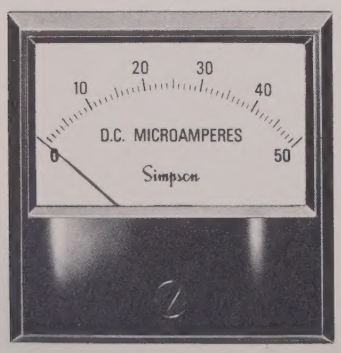
SIMPSON INSTRUMENTATION PRODUCTS MODEL 2701



CENTURY SERIES

introducing Simpson's new panel instrument design concept...

A MODERN BLEND OF PHENOLIC AND GLASS



Now you can have Simpson's annular panel instrument construction in this clean-cut modern design. Century Series panel instruments have rugged phenolic cases and glass windows. That's especially important where you can't use plastic. And they're rugged inside, too. With Simpson movements that are famous for their "stay accurate" dependability. New Century Series panel instruments are now available to meet your size and electrical specifications.

Simpson ELECTRIC COMPANY

AGM DIVISION

5200 W. Kinzie Street, Chicago, Illinois 60644 • Phone (312) 379-1121

SIMPSON ELECTRIC COMPANY

INSTRUCTION MANUAL MODEL 2701 DIGITAL MULTIMETER

SIMPSON ELECTRIC COMPANY 5200 WEST KINZIE CHICAGO ILLINOIS 60644 (312) 379-1121

Copyright, 1971 Simpson Electric Co.
9-71 OMJ Hinz

Printed in U.S.A.
Part #5-113719

SIMPSON INSTRUMENTATION PRODUCTS MODEL 2701

SIMPSON INSTRUMENTATION PRODUCTS WARRANTY

All instruments in the SIMPSON INSTRUMENTATION PRODUCTS WARRANTY are warranted to the original purchaser to perform according to published specifications upon delivery, and to be free from defects in material or workmanship for one year (12 months) from the date of shipment. Within this period, any instrument which is returned, transportation charges prepaid, to our repair department or one of our authorized service agencies, and which we confirm to be defective, will be repaired or adjusted, (or at our option replaced) without charge.

This warranty does not apply to batteries, tubes, transistors, diodes, and other solid state devices, nor to instruments which have been altered outside of our service organization, operated in an abnormal manner, or abused. This warranty is expressed in lieu of all other liabilities expressed or implied. We are not liable for consequential damage.

SIMPSON ELECTRIC COMPANY

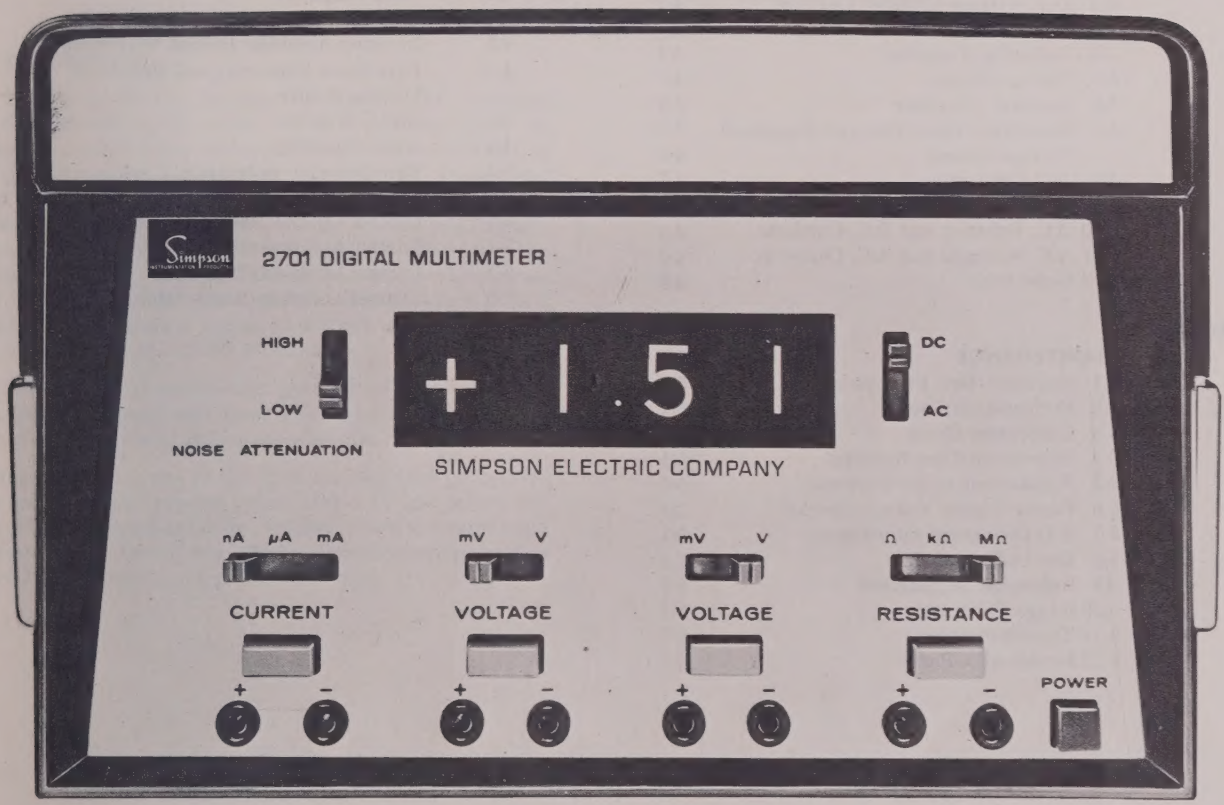


FIGURE 1-1
MODEL 2701 DIGITAL MULTIMETER

TABLE OF CONTENTS

SECTION		PAGE
I	**GENERAL INFORMATION**	1-1
	1.1 Introduction	1-1
	1.2 Description	1-1
	1.3 Specifications	1-1
II	**UNPACKING AND INSTALLATION**	2-1
	2.1 Incoming Inspection	2-1
	2.2 Power Source Requirements	2-1
	2.3 Mounting Instructions	2-1
III	**OPERATING INSTRUCTIONS**	3-3
	3.1 General	3-1
	3.2 Front Panel Description	3-2
	3.3 Operating Instructions	3-3
IV	**THEORY OF OPERATION**	4-1
	4.1 Main Amplifier	4-2
	4.2 D.C. Voltage Chopper Channel	4-1
	4.3 A.C. Voltage Channel	4-1
	4.4 Summing Amplifier	4-1
	4.5 Voltage Supply	4-1
	4.6 Inverter Amplifier	4-1
	4.7 Impedance Converter and Regulated Voltage Source	4-1 4-1
	4.8 A-D Converter	4-2
	4.9 Input Circuitry	4-2
	4.10 D.C. Voltages and D.C. Currents	4-2
	4.11 A.C. Voltages and A.C. Currents	4-2
	4.12 Resistance	4-2
V	**MAINTENANCE**	5-1
	5.1 Required Test Equipment	5-1
	5.2 Performance Check	5-1
	5.3 Calibration Check	5-1
	5.4 Instrument Case Removal	5-1
	5.5 Adjustment and Calibration	5-1
	5.6 Power Supply Voltage Checks	5-1
	5.7 A-D Converter Adjustment	5-1
	5.8 Zero Adjustment	5-1
	5.9 Reference Adjustment	5-1
	5.10 Range Calibration	5-2
	5.11 Troubleshooting	5-7
	5.12 Replaceable Parts	5-8

LIST OF TABLES

TABLE NUMBER		PAGE
1-1	Specifications	1-2
5-1	Recommended Test Equipment	5-2
5-2	Calibration Adjustment Chart	5-2
5-3	Power Supply Specifications	5-2

LIST OF ILLUSTRATIONS

FIGURE NUMBER		
1-1	Model 2701 Digital Multimeter	1-1
2-1	Horizontal Position	2-2
2-2	Sloping Position	2-2
3-1	Front Panel Description	3-2
4-1	Main Amplifier	4-3
4-2	Inverter Amplifier	4-4
4-3	Inverter Amplifier Output Waveform	4-5
4-4	Impedance Converter and Regulated Voltage Source	4-5
4-5	A-D Converter	4-6
4-6	Input Circuitry	4-8
5-1	Power Supply Schematic	5-3
5-2	Control Location (Front)	5-4
5-3	Control Location (Rear)	5-4
5-4	Control Location (Bottom)	5-5
5-5	Control Location (Top)	5-5
5-6	Control Location (Right Side)	5-6

1.1 INTRODUCTION

1.1.1 The new Simpson 2701 Digital Multimeter displays A.C. or D.C. voltage in six ranges, A.C. or D.C. current in nine ranges, and resistance in eight ranges—all at the touch of a button. Even unskilled personnel can make fast, accurate measurements with this instrument. Simply set the magnitude switch, then press the button. The reading appears as a three digit number, complete with polarity sign and decimal point.

1.1.2 Like all Simpson VOM's, the new 2701 is built for rugged dependability and maximum convenience. Solid-state circuitry assures minimum maintenance problems. The decimal point automatically switches over three decade ranges. The Adjust-A-Vue ® Handle folds down for use as a stand.

1.1.3 The new 2701 Digital Multimeter is replacing conventional VOM's in many laboratory, test bench, and production line applications. It's available through your Industrial Electronic Parts Distributor.

1.2 DESCRIPTION

1.2.1 The Model 2701 is designed to measure D.C. voltages from .01 millivolts to 600 volts, and D.C. currents from 1.0 nanoamperes to 999 milliamperes. Accuracies of these functions are ±1.0% of reading, and ±.2% of full scale. A.C. voltage and current functions have the same range, with accuracies of ±1.5% of reading, and ±.2% of full scale. The D.C. resistance function will measure from 0.01 ohms to 999M ohms. The accuracy of the resistance ranges is ±.5% of reading, and ±.2% of full scale from 0.01 ohms to 999K ohms. Measurement accuracy from 1 megohm to 999 megohms varies from ±1% at 1 megohm to ±10% at 100 megohms, ±.2% of full scale.

1.1.2 The Model 2701 incorporates pushbutton input switching; lever type mode, range and noise attenuator switching; automatic polarity switching and range selection.

1.2.3 Components in the Model 2701 are mounted on printed circuit boards, which provide ready access to test points and substitution of entire assemblies. Display effectiveness of readout is increased by the use of a filter to minimize reflections from external light sources and internal tube glow.

1.3 SPECIFICATIONS

1.3.1 Table 1-1 lists the electrical and physical specifications for the Model 2701 Digital Multimeter.

TABLE 1-1 SPECIFICATIONS

1. DC/AC Voltage

		DC			AC 30 Hz-500 Hz	
	Range	Accuracy	Resolution	Input Impedance	Accuracy	Resolution	Input Impedance
Millivolt	0.01-9.99†	±1.0%	10 uV	0.2 MΩ	±1.5%	10 uV	5.0 MΩ
	10.0-99.9	of	0.1 MV	2.0 MΩ	of	0.1 MV	15 pf
	100.-999	reading	1.0 MV	5.0 MΩ	reading	1.0 MV	
Volts	1.00-9.99	±0.2%	10 MV	5.0 MΩ	±0.2%	10 MV	5.0 MΩ
	10.0-99.9	of	0.1 V	5.0 MΩ	of	0.1 V	15 pf
	100.-600.	F.S.	1.0 V	5.0 MΩ	F.S.	1.0 V	

2. DC/AC Current

		DC			AC 30 Hz-3000 Hz	
	Range	Accuracy	Resolution	Input Impedance	Accuracy	Resolution	Input Impedance
Nano Amps	100.-999	±1.0%	1.0 nA	11 KΩ	±1.5%	1.0 nA	11 KΩ
Micro Amps	10.0-99.9	of	10 nA	3 KΩ	of	10 nA	3 KΩ
	10.0-99.9	reading	0.1 uA	1 KΩ	reading	0.1 uA	1 KΩ
	100.-999	±0.2%	1.0 uA	0.8 KΩ	±0.2%	1.0 uA	0.8 KΩ
Milliamps	1.00-9.99	of	10 uA	2.4 Ω	of	10 uA	2.4 Ω
	10.0-99.9	F.S.	0.1 mA	0.6 Ω	F.S.	0.1 mA	0.6 Ω
	100.-999.		1.0 mA	0.4 Ω		1.0 mA	0.4 Ω

3. Resistance

	Range	Accuracy	Resolution	
Ohms	0.01-9.99 * *	±0.5%	0.01Ω	
	10.0-99.9	of	0.1Ω	
	100-999	reading	1.0Ω	Test
K Ohms	1.00-9.99	±0.2%	10Ω	Current
	10.0-99.9	of	100Ω	Less
	100-999	F.S.	1KΩ	Than
Megohms	1.0-9.99	±1.0%*	10KΩ	1.4 MA
	10.0-99.9	±2.5%*	100KΩ	
	100-999	±10%*	1MΩ	

4. Operating Temperature −10 °C to +35 °C
5. Response Time
   (A) Without filter − 1 second
   (B) With filter − 4 seconds
6. Power Required 105-130 VAC, 60 Hz, 60 Watts
7. Polarity: Automatic with Indication
8. Size: 5-1/2"H x 10"W x 10"D (Approx.)
9. Weight: Approx. 14.3 lbs.

*Plus or minus 0.2% of F.S.

**Accuracy on this resistance range is influenced by the lead resistance and contact resistance. By subtracting the lead resistance value, the actual resistance can be measured to within 1%.

†Rated accuracy on AC millivolts applies to readings of 1.0 millivolt or more.

2.1 INCOMING INSPECTION

2.1.1 Examine the external covering for obvious damage. Notify the shipper if there is any sign of external damage. If not, remove the covering and again examine for obvious damage from shock, water leakage, or other faults. It should be physically free of marks or scratches and in good electrical order upon receipt. Also check for supplied accessories, and test the electrical performance of the instrument using the procedure outline in paragraph 5.3.

2.2 POWER SOURCE REQUIREMENTS

2.2.1 The Model 2701 is to be operated from 115 volts, 50 to 60 Hz A.C. source.

2.3 MOUNTING INSTRUCTIONS

2.3.1 The instrument can be set horizontally with the handle positioned along the top as shown in Figure 2-1. A convenient sloping position can be obtained by swinging the handle under the instrument and locking it in place.

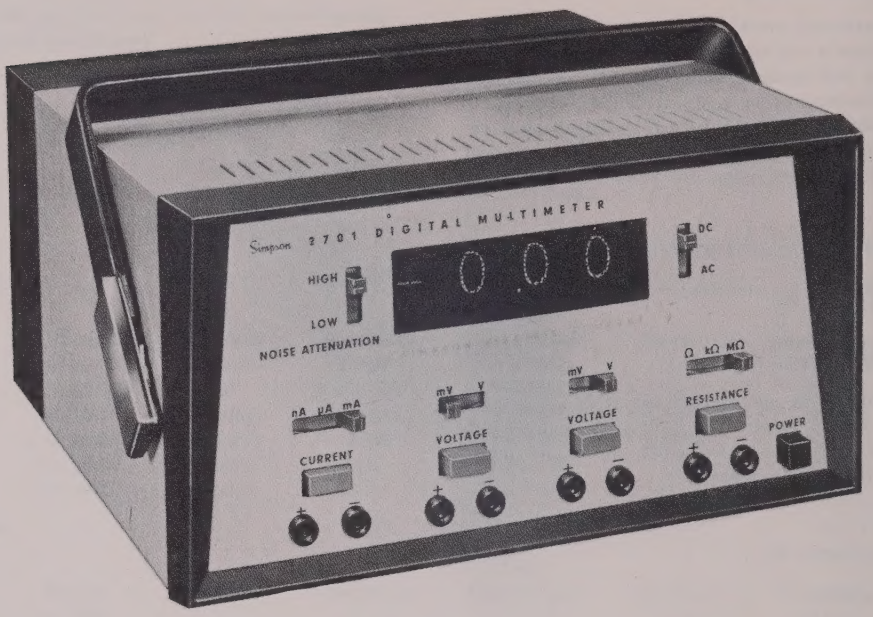


FIGURE 2-1 HORIZONTAL POSITION

FIGURE 2-2 SLOPING POSITION

3.1 GENERAL

3.1.1 The Model 2701 will measure D.C. and A.C. voltages from 0.01 millivolts to 600 volts, D.C. and A.C. current from 1.0 nanoamperes to 999 milliamperes, and D.C. resistance from 0.01 ohms to 999 megohms, to three significant figures. Automatic polarity and range selection and a fixed sampling rate are standard features of this instrument.

3.2 FRONT PANEL DESCRIPTION

3.2.1 Description of controls and indicators is given in Figure 3-1.

3.3.1 The clear presentation on the front panel makes the operation of the instrument self-explanatory. It is however advisable to note the following important points.

3.3.2 Connect power cord to 120 Volt line voltage source as indicated on rear of unit. When the Power Switch (on the lower right-hand corner of the front Panel) is depressed the indicating tubes will light up, thus showing that the instrument is ready for use.

3.3.3 Four pairs of input terminals are available on the front panel. All functions and polarity are clearly indicated. All four inputs may be simultaneously connected. Under these conditions, up to 500V potential difference between inputs is permitted. For single input connection, Voltage up to 600V is permissible.

3.3.4 One input measurement at a time will be displayed when the function switch (Interlocked Push Button) is depressed. When using other function switches the current input will remain shunted at all times. The unit of measurement of each input is set with the appropriate Range Switches. The decimal point will automatically be positioned by the internal circuitry when a measurement is made. If the approximate value of an input is unknown, always start with the highest input range to prevent possible overloads. Although the instrument is well protected with 4 Fuses at 4 different points (i.e., 3 on input measuring circuits and 1 on supply voltage circuit) it is always advisable to avoid abuse of any measuring instrument.

3.3.5 If the input contains unwanted noise causing the reading to fluctuate, the Noise Attenuation Switch should be set at "High" to help stabilize the reading.

3.3.6 For measurements in the MΩ range, the connecting leads should be kept as short as possible to avoid noise pickup.

3.3.7 For A.C. Voltage measurements, the D.C./A.C. Mode Selector Switch should be set to A.C. position. The "~" symbol will then appear instead of the polarity sign on the readout. Also, the resistance Selector Switch should be set at Ω range. Due to high sensitivity of the amplifier, with the Range Switch in the "MV" position, some value (less than 10) may be indicated with the input leads shorted. This value however will not introduce any error on the actual measurement.

SIMPSON INSTRUMENTATION PRODUCTS MODEL 2701

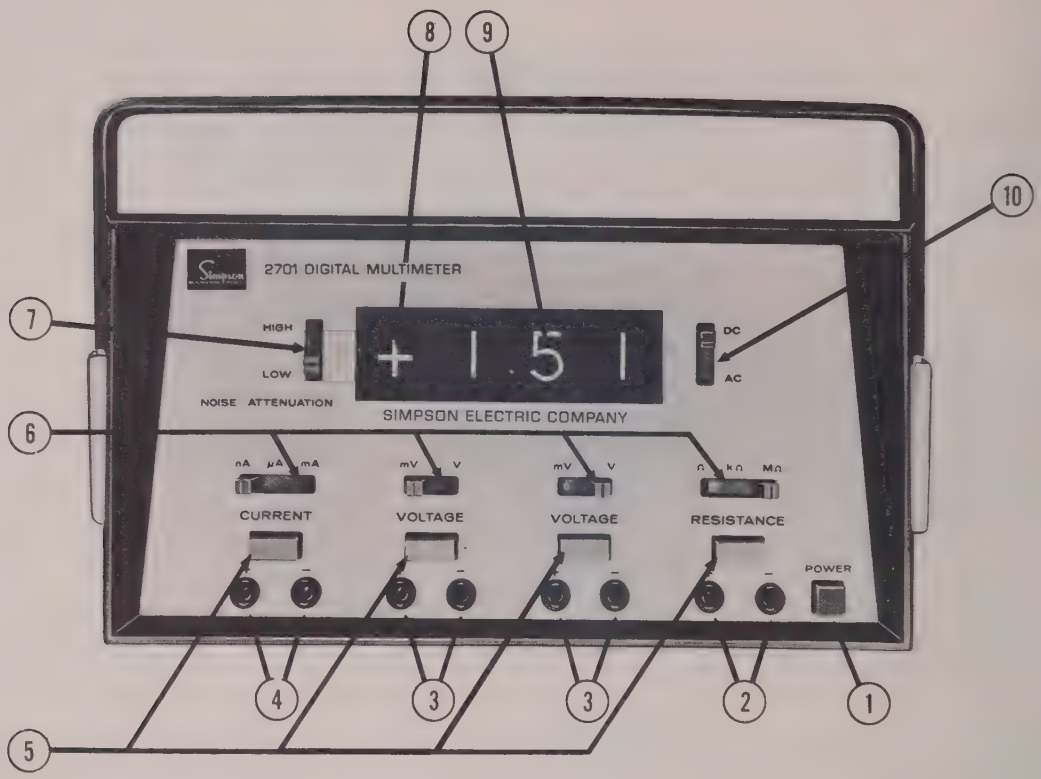


FIGURE 3-1 FRONT PANEL DESCRIPTION

1. POWER switch: Turns instrument power ON and OFF.
2. RESISTANCE input: Is used when measuring D.C. resistance.
3. VOLTAGE inputs: Are used when measuring D.C. or A.C. voltage.
4. CURRENT input: Is used when measuring D.C. or A.C. current.
5. INPUT switch: Selects input required for proper measurement.
6. RANGE switches: Select the correct sensitivity for each input.
7. NOISE ATTENUATOR switch: Provides a fast or slow response time eliminating erratic readings when instrument is used in the D.C. and A.C. modes.
8. POLARITY indicator: Indicates the polarity of the input voltage and indicates when the instrument is set to the A.C. mode.
9. READOUT DISPLAY: Indicates input voltage value using neon numerical glow tubes.
10. MODE switch: Selects either D.C. or A.C. measurement mode of operation.

4.1 MAIN AMPLIFIER (LP2) (See Figure 4-1)

4.1.1 The main amplifier consists basically of three stages:

a) The chopper channel for amplification of D.C. voltages.
b) The A.C. voltage channel.
c) The summing amplifier.

The open loop gain of the chopper channel is approximately 3.5 x 10^4, the gain of the summing amplifier is approximately 40, and the gain of the entire amplifier is 1400 due to negative feedback. This feedback voltage is taken from a voltage divider network to assure constant amplification and higher long term stability.

4.2 D.C. VOLTAGE CHOPPER CHANNEL

4.2.1 In order to obtain drift free D.C. amplification, the shifting of the operating point of the various amplifier stages, particularly transistors, has to be avoided. No such shifting takes place in A.C. amplifiers because of the capacitive coupling between stages and the isolation of the voltage levels. Advantage is taken of this fact by chopping the D.C. voltage, amplifying the A.C. signal and rectifying it again at the output of the amplifier. The amplifier uses none of the usual mechanical choppers, however, but a field effect transistor is employed to great advantage which shows a high input impedance and has a low noise factor. By shaping the output square wave produced by a pair of transistors, undesirable noise voltages caused by two steep a signal slope are avoided. This traperzoidal voltage triggers the field effect transistor in the chopper. Two potentiometers adjust the trapezoidal voltage and the compensating circuit for stray and transistor capacity. To guard against overvoltage at the input, two diodes are parallel reverse connected. The chopped D.C. signal arrives now at the narrow band chopper amplifier. In the feedback loop of the amplifier stage, a band pass filter will be found, tuned to the frequency of the chopper. This suppresses all other noise components. The re-rectification is performed with two transistors, which are triggered in synchronism with the multivibrator controlled chopper frequency. Another transistor serves as a signal inverter, while two more transistors and capacitors integrate the incoming signal. This filters the D.C. voltage. Special precision resistors are used for temperature compensation.

4.3 A.C. VOLTAGE CHANNEL

4.3.1 When A.C. voltages are to be measured, the voltage divider will be by-passed and the signal will go directly to the input which consists of several double transistor stages. In order to have control over the frequency response, the frequency dependent feedback is applied around every double stage. Stability is improved with the help of two capacitors. A special diode allows for quick recovery in case of overload. A transistor and capacitor serve to compensate for stray and transistor capacitance.

4.4 SUMMING AMPLIFIER

4.4.1 The summing amplifier delivers the power amplification necessary for further processing of the signal. It is used for D.C. and A.C. amplification. A diode limiter circuit is incorporated to assure prompt recovery of the amplifier in case of overload. This is specifically necessary here, since otherwise the removal of the overload at the input through the range switch would still block the overloaded amplifier, causing trouble. A diode limits the output voltage to +24V.

4.5 VOLTAGE SUPPLY

4.5.1 In order to have constant voltages available for the preamplifier stage, stabilizing circuits have been used within the main amplifier with Zener diodes providing reference voltages. Protecting diodes are connected between base and emitter to prevent over-voltages.

4.6 INVERTER AMPLIFIER (LPI)

4.6.1 The voltages applied to the inverter amplifier will be inverted to have a voltage of opposite polarity to the input voltage. If a negative signal is applied at input E of the amplifier, inversion takes place so that point P will show a positive polarity. A current proportional to this voltage applied to resistor R1, flows through relay contact "d" and represents the input current for the comparator amplifier. The comparator in this function has unity gain. With a positive voltage at the input E, the relay contact "d" will be switched, controlled by logic circuitry, and the voltage will be directly transformed into input current for the amplifier through the resistor R2. The switching of the relay also actuates the polarity indicator (Refer to Figure 4-2).

4.6.2 The output of the amplifier will be fed back to the input through M in D.C. voltage. This will increase the input impedance to the total circuitry, bringing it to a high value.

4.6.3 This amplifier will be used to rectify the A.C. voltages. in this mode, all switches designated A.C. will be switched. This switching action reduces the input impedance of the amplifier, which in turn raises the output voltage at point P. Additionally, the diodes will be put into the circuit in such a way that phase reversal at the output results in the dotted waveform as shown. (Refer to Figure 4-3).

4.7 IMPEDANCE CONVERTER (LP8) AND REGULATED VOLTAGE SOURCE

4.7.1 The impedance converter is switched in only in the A.C. measurement position. Its function is to increase the input impedance of the amplifier while providing a low impedance output to the following stages.

4.7.2 Cascaded transistor stages are used to provide the necessary high input impedance, with diodes across the base-emitter terminals, for protection against excessive voltages. A bootstrap circuit is incorporated to prevent the base resistance from lowering the input impedance, originally increased by the cascaded transistors.

4.7.3 On this same circuit board is a control circuit that provides the 60V and 61.5V used in several places throughout the unit.

SIMPSON INSTRUMENTATION PRODUCTS MODEL 270

4.7.4 A Zener diode (D), whose current is controlled by a potentiometer, R6, serves as a voltage reference source for the differential amplifier. Temperature compensation for the Zener diode is provided by placing R14 close to the diode.

4.8 A-D CONVERTER (Refer to Figure 4-5)

4.8.1 The A-D Converter consists of a comparator amplifier (LP7) followed by gating circuits (LP3), an electronic counter comprised of 3 decades (LP4-5-6) and their corresponding balancing circuits. Their purpose is to produce a current which is proportional to the number of counts. This is achieved by providing a very accurate reference voltage with balancing resistors arranged via electronic switches. The conversion is carried out as follows:

4.8.2 The incoming signal passes through a filter circuit, which may be switched in or out, as required, and then into the comparator amplifier. The filter is used for D.C. voltages containing ripple or A.C. voltages, as well.

4.8.3 With a positive current flow, at the input of the Comparator amplifier, the signal range indicator will be activated. The gate to the counter will now open and the clock pulses will be counted by the counter (LP4-5-6). The counter controls electronic switches which allow equivalent currents to reach the Comparator amplifier input. These are derived from a voltage reference and precision resistors. When the input current and the Comparator current are equal, no input voltage will exist at the Comparator amplifier. It will turn off and the signal range indicator closes the gate, holding the readout. If the input current exceeds the maximum Comparator current, the counter will count up to 999. Since no zero current condition has been reached, the counting continues and the next pulse resets the counter to 000 and switches the ring counter to its next position. This in turn moves the decimal point to the next decade and simultaneously switches the range switch at the input of the main amplifier. Now the whole process repeats. If there is still no zero current condition reached, the ring counter will be reset again and the decimal point moves to its extreme position. If, in this position, an overvoltage takes place, the measured variable is outside the selected range and the range switch must be set to the next higher range.

4.8.4 If the input current drops slightly, after a measurement, the Comparator amplifier will switch in the opposite direction and cause the signal range indicator to open the associated gate and the clock pulse will set the counter to zero. Thereafter, a new counting cycle starts until a zero current condition is reached. If the new value is less than 098, the ring counter will reset again, which results in a better range for the indicator.

4.8.5 In case the signal range indicator and the gate remain open, in spite of a 000 counter position, a negative current input must prevail at the input of the Comparator amplifier. This causes the next clock pulses via the dynamic input of the AND gate to set the bistable multivibrator FFP. The multivibrator flips and switches the relay K and contact "d" to actuate the other circuit path of the Inverter amplifier. Thus, again, a positive current input is available at the Comparator amplifier and zeroing can take place. In conjunction with the multivibrator FFP, the polarity indicator is activated displaying the negative sign.

4.9 INPUT CIRCUITRY (Refer to Figure 4-6)

4.10 D.C. VOLTAGES AND D.C. CURRENTS

4.10.1 For voltage measurements the input signal will be connected to the main amplifier through an input resistor of different magnitude; controlled by the decimal indication circuit. The signal will be amplified to reach a certain amplitude, proportional to the input signal. For current measurements no input resistor switching takes place and only one constant value is inserted into the circuit. Range switching is accomplished by changing shunt values.

4.10.2 From the main amplifier (LP2), the signal flows to the inverter amplifier (LP1), which for D.C. measurements serves as a phase inverter only. From here the signal is fed to the comparator amplifier (LP7), which performs Analog to Digital conversion. Dependent on polarity used, the relay will switch the output to the inverter amplifier or the direct path.

4.10.3 The voltage from the output of the inverter amplifier, independent of relay action, will be routed to the input stage of the voltage circuitry through a high value resistor. Through this coupling action an increase of the input impedance is obtained.

4.11 A.C. VOLTAGES AND A.C. CURRENTS

4.11.1 When measuring A.C. quantities all switches designated A.C. will be switched on. This connects the impedance changer into the circuit while the coupling loop is opened.

4.11.2 Because of the very high input impedance of the impedance changer essentially no loading of the circuit under measurement takes place, and no feedback circuit is required. The A.C. signal reaches the main amplifier and goes to the inverter amplifier, which rectifies it as previously described. Further signal processing is the same as the D.C. signals. In order to have the same terminal resistance for current measurements in the shunt group, the resistance value will be duplicated against circuit ground, ahead of the impedance amplifier.

4.12 RESISTANCE

4.12.1 Two different measuring principles are applied for resistance measurements.

4.12.2 In the Ohm range a current will be fed into the specimen and the voltage drop will be measured. Error compensation will be applied for the higher range between 100 and 999, since otherwise too great an error would occur because of the use of series resistor in the take off circuit from the reference voltage.

4.12.3 In the K Ohm and the M Ohm range a fixed voltage over a series resistor is applied at the input of the amplifier. Measurement of the unknown resistor is accomplished by the fact that the negative feedback resistance, in this case the specimen, must be accurately proportional to the output voltage. In this way the desired accuracy as well as range will be obtained.

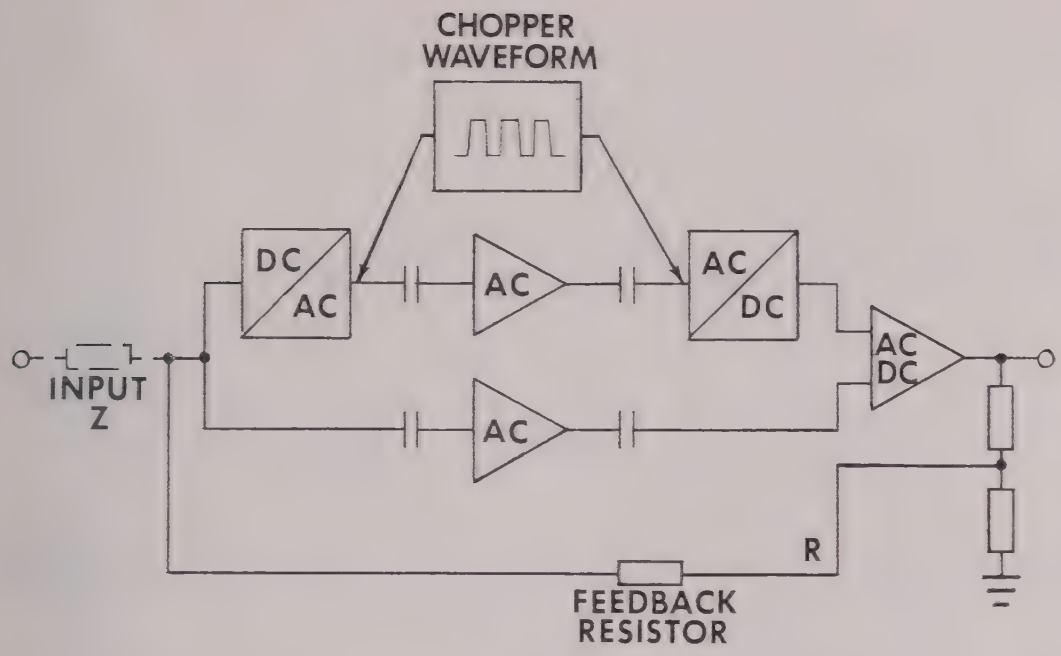


FIGURE 4-1A MAIN AMPLIFIER, BASIC BLOCK DIAGRAM

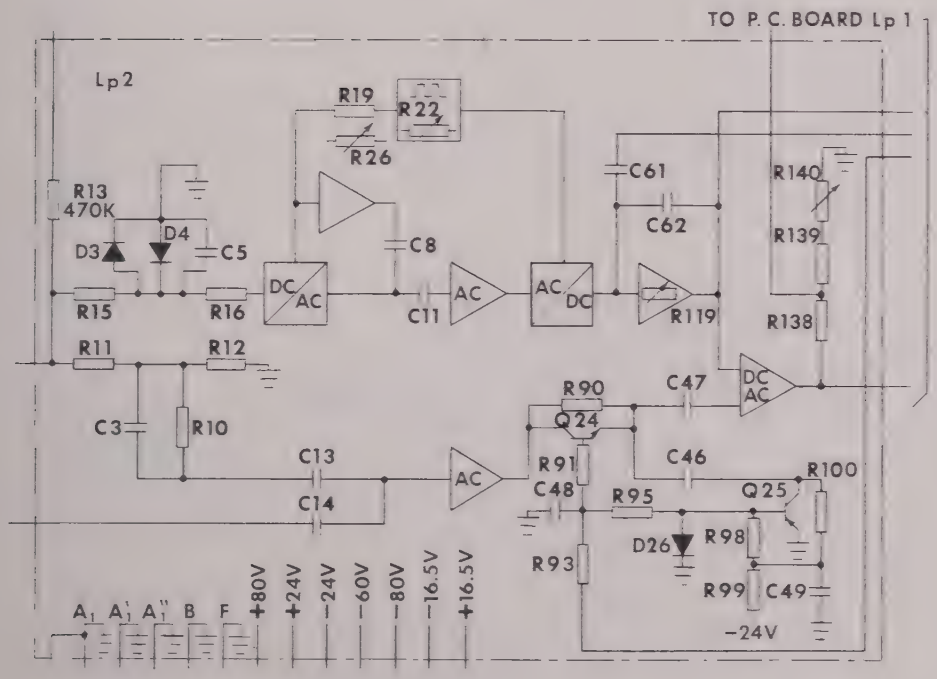


FIGURE 4-1B MAIN AMPLIFIER, FUNCTIONAL BLOCK DIAGRAM

SIMPSON INSTRUMENTATION PRODUCTS MODEL 2701

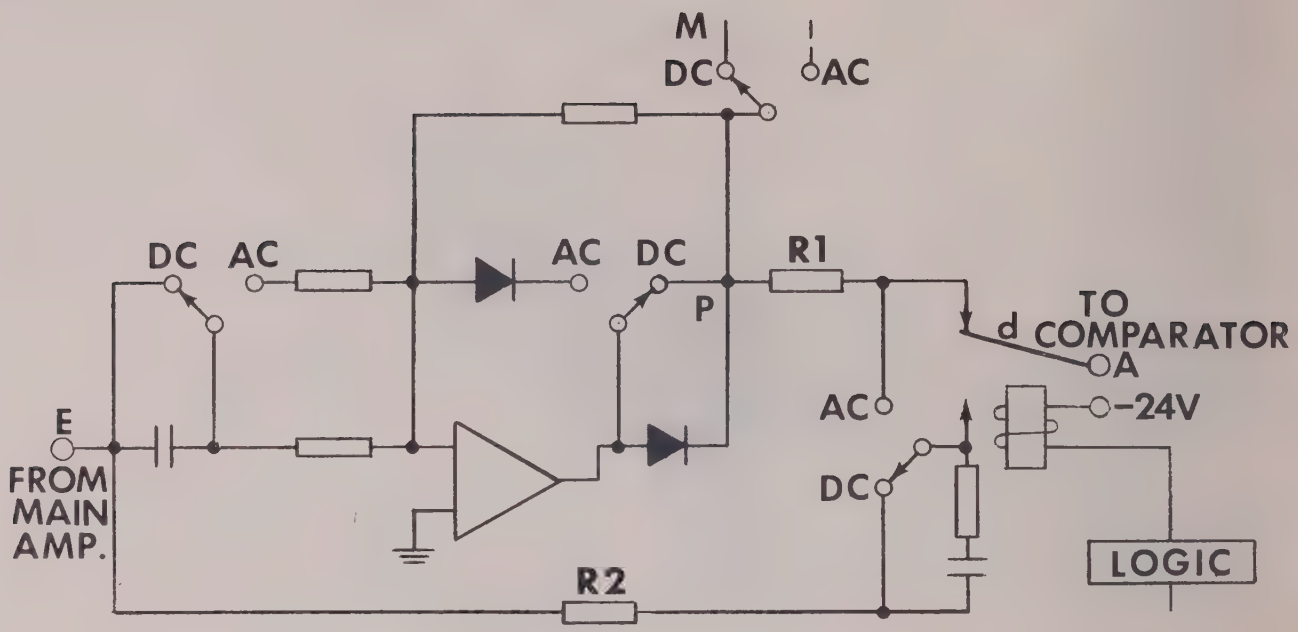


FIGURE 4-2A INVERTER AMPLIFIER BASIC BLOCK DIAGRAM

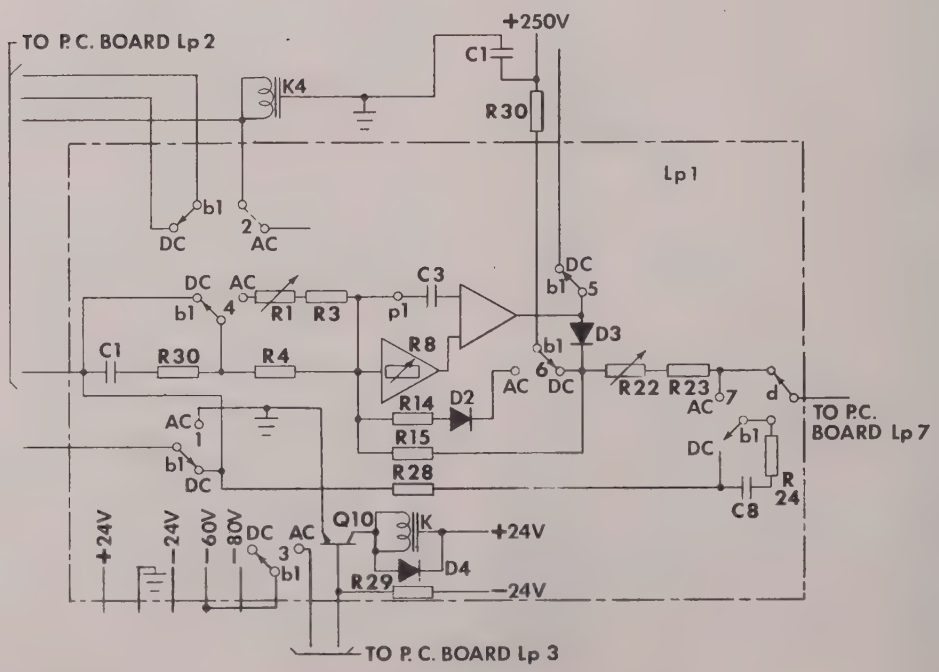


FIGURE 4-2B INVERTER AMPLIFIER FUNCTIONAL BLOCK DIAGRAM

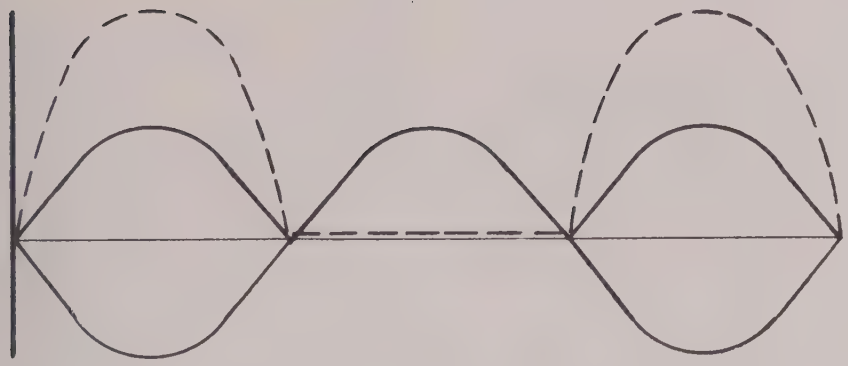


FIGURE 4-3 INVERTER AMPLIFIER OUTPUT WAVEFORM

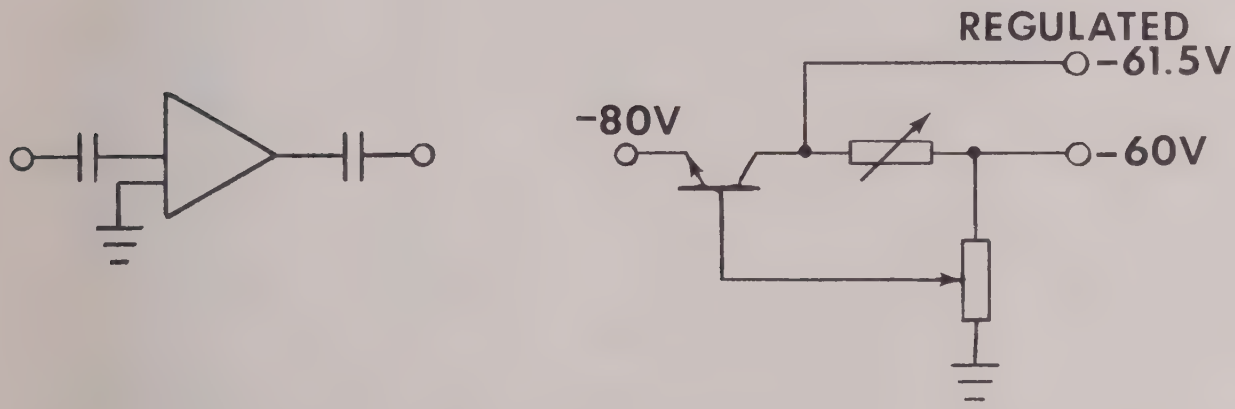


FIGURE 4-4A IMPEDANCE CONVERTER & REGULATED VOLTAGE SOURCE BASIC BLOCK DIAGRAM

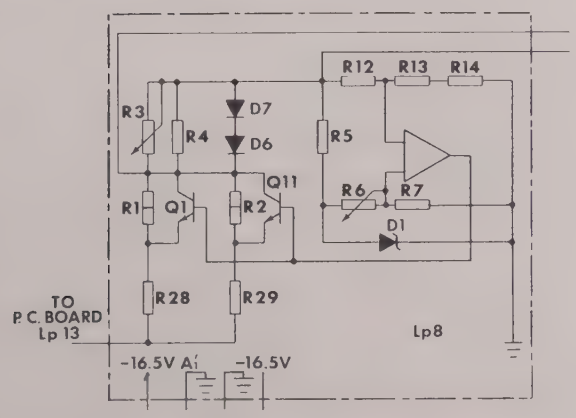


FIGURE 4-4B IMPEDANCE CONVERTER & REGULATED VOLTAGE SOURCE FUNCTIONAL BLOCK DIAGRAM

SIMPSON INSTRUMENTATION PRODUCTS MODEL 2701

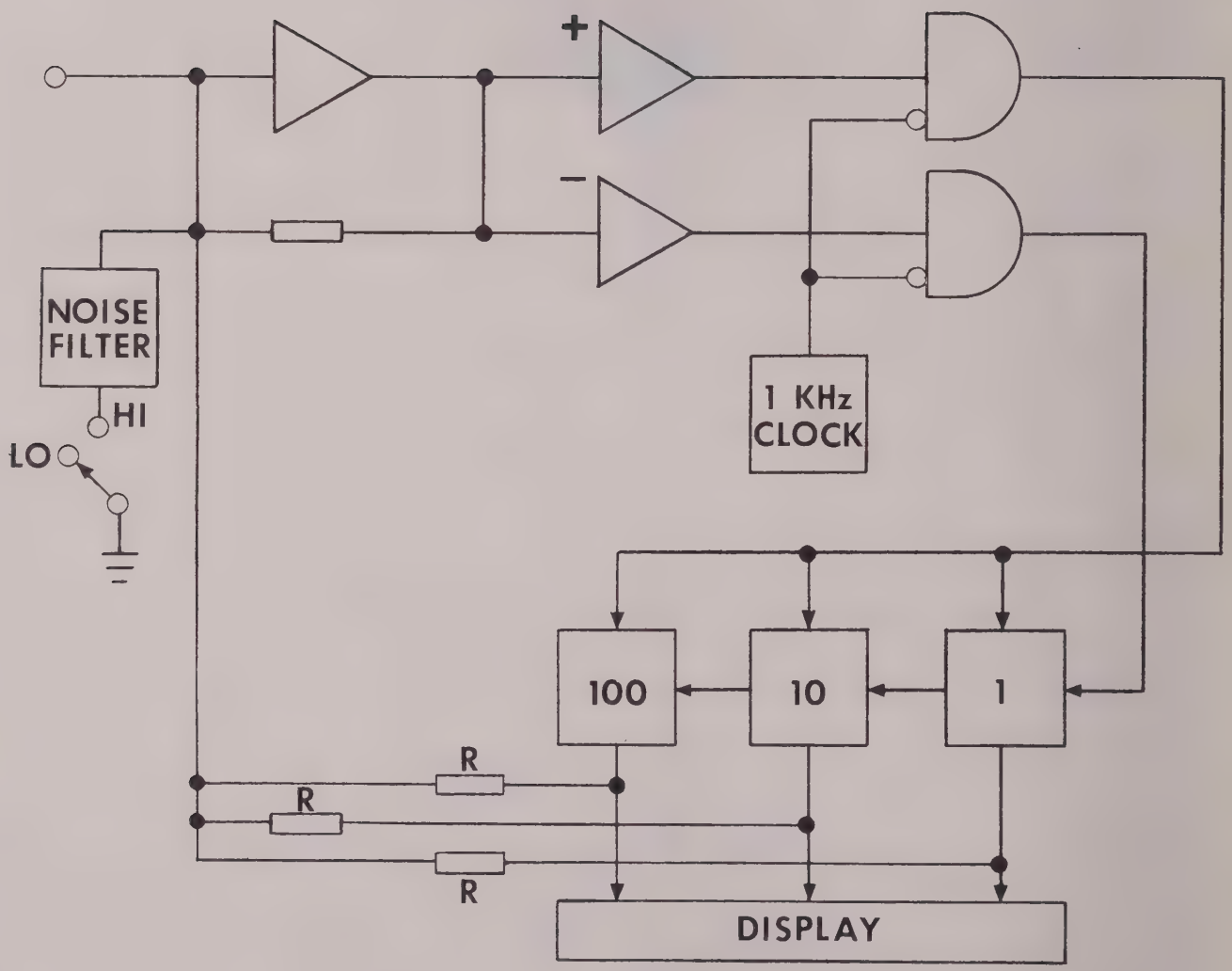


FIGURE 4-5A A-D CONVERTER BASIC BLOCK DIAGRAM

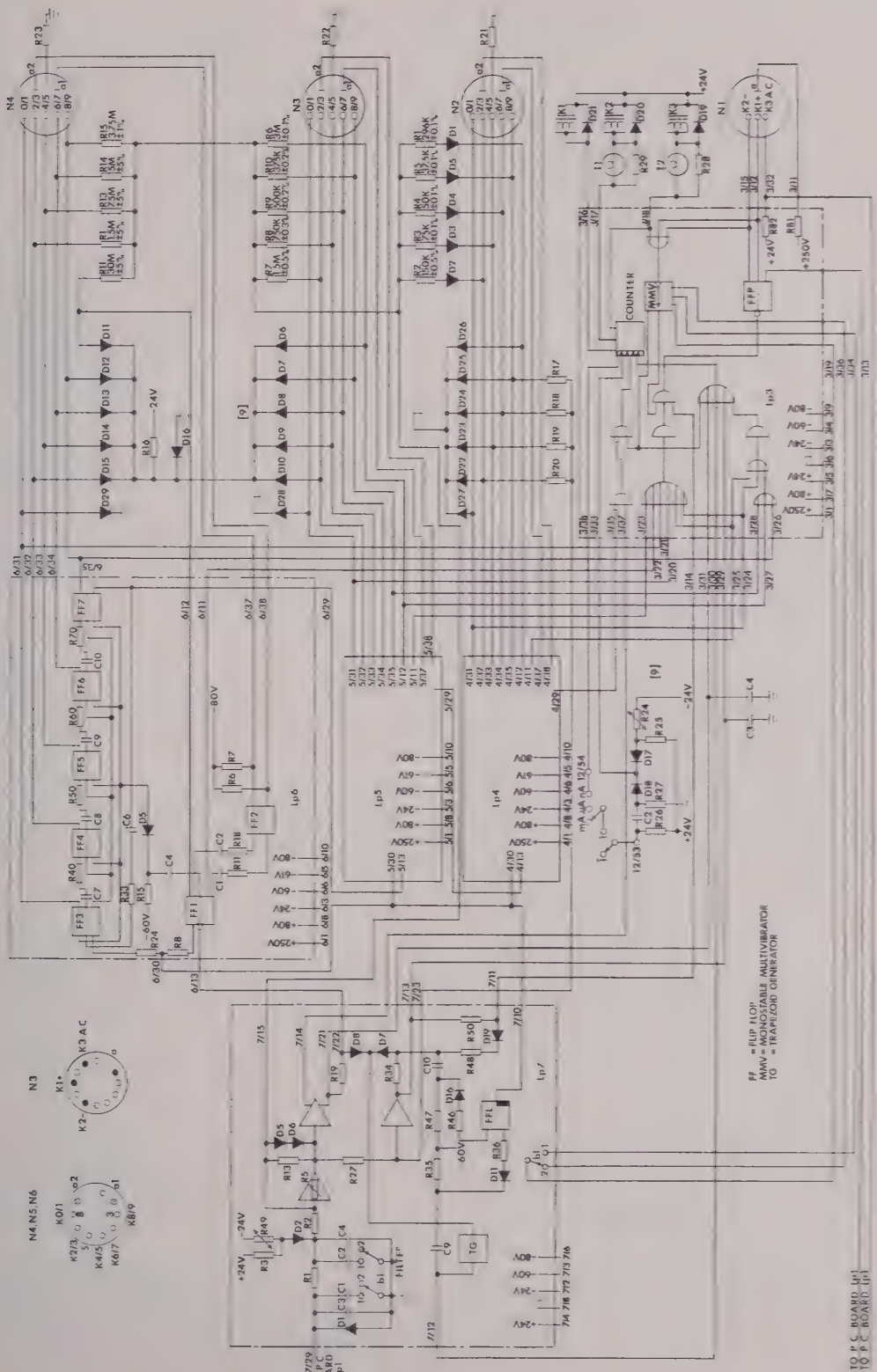


FIGURE 4-5B A-D CONVERTER FUNCTIONAL BLOCK DIAGRAM

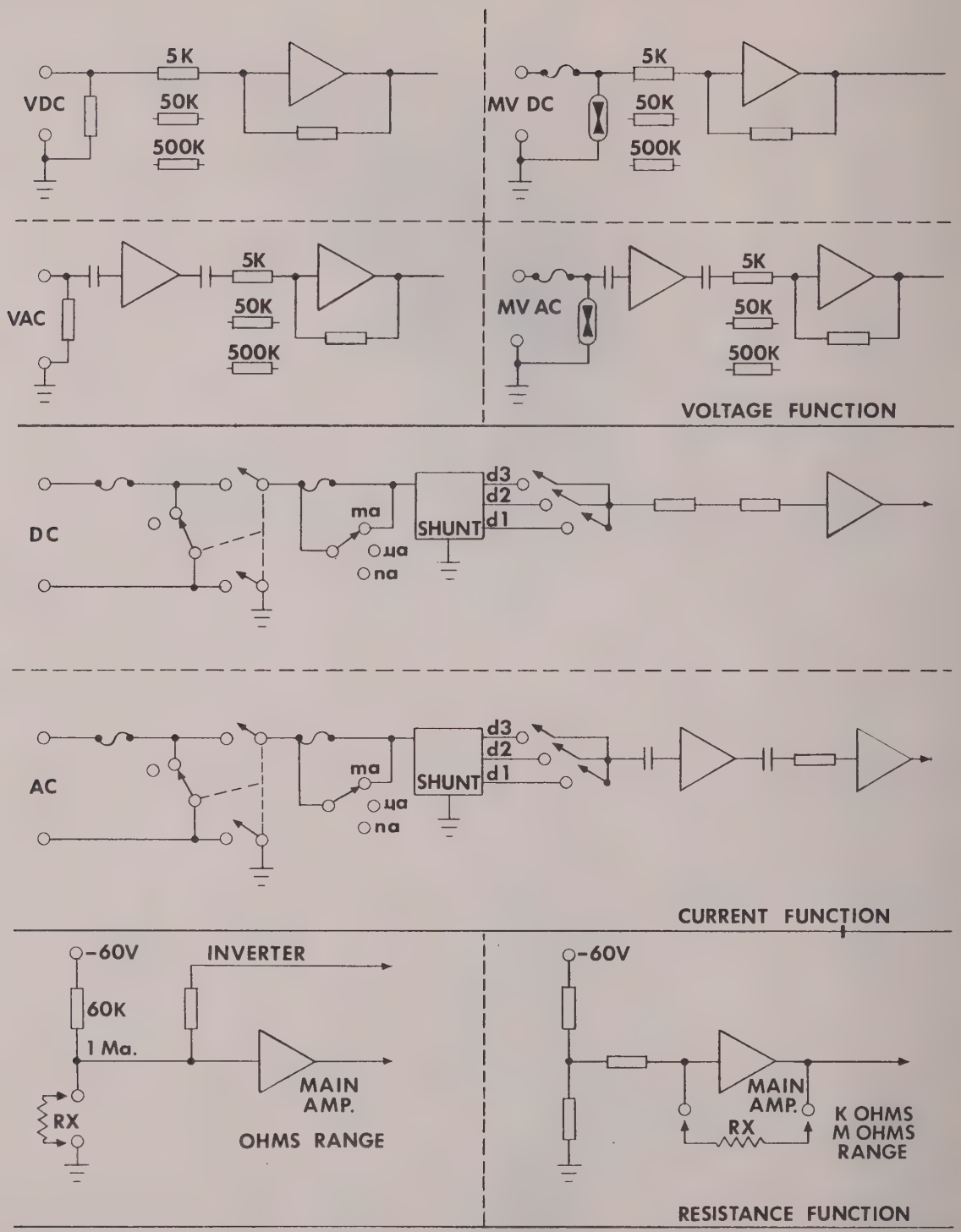


FIGURE 4-6 INPUT CIRCUITRY BLOCK DIAGRAM

5.1 REQUIRED TEST EQUIPMENT

5.1.1 Table 5-1 lists recommended test equipment required for checking performance, calibration, and trouble-shooting for the Model 2701. Test equipment other than that listed may be used if the specifications equal or exceed the required characteristics.

5.2 PERFORMANCE CHECK

5.2.1 The following performance check is used to verify the specifications of the Model 2701. It can be used upon receipt of a new instrument, for routine preventive maintenance and following repair. If the instrument fails to meet the performance check at any time, proceed to the appropriate calibration procedure to correct the malfunction.

5.3 CALIBRATION CHECK

a. Connect power cord to appropriate line voltage source as indicated on rear of unit.

b. Connect Model 2701 to the output of the calibrator.

c. Turn on power to the Model 2701 and Calibrator allowing a 15 minute warm-up period.

d. Set the Range switch on Model 2701 to mV.

e. Set the Mode switch on Model 2701 to D.C.

f. Set the NOISE ATTENUATOR switch on Model 2701 to LOW.

g. With the Calibrator output set at OV short the Model 2701 input terminals (− to +).

h. The Model 2701 should read −.001 to +.001. If adjustment is needed, follow the procedure outlined in Section 5-7 A-D converter Adjustment.

i. Remove short from INPUT.

j. Apply output of Calibrator to INPUT of Model 2701 and check calibration according to Table 5-2 making necessary control adjustments on the Model 2701 and the Calibrator.

NOTE:

Before changing Ranges or Functions on the Calibrator or Model 2701 always turn the Calibrator output to "ZERO".

5.4 INSTRUMENT CASE REMOVAL

5.4.1 To remove the case for service or calibration remove the two (2) screws holding the back cover and remove the cover.

NOTE:

The fan must be disconnected before the back cover can be completely removed.

Next remove the two (2) fastening strips held by four (4) screws, then slide the instrument out of the case.

5.5 ADJUSTMENT AND CALIBRATION

5.5.1 The following tests and adjustments should be made only after the Performance Checks, paragraphs 5-3 through 5-5, have shown the Model 2701 to be out of specifications.

5.6 POWER SUPPLY VOLTAGE CHECKS

5.6.1 Power Supply specifications are given in Table 5-3. (Also Refer to Figure 5-1).

5.7 A-D CONVERTER ADJUSTMENT (See Figure 5-5)

5.7.1 Remove main amplifier (module 2a, b, c) and replace with the Main Amplifier Load Adapter. (To obtain information and drawings on the Main Amplifier Load Adapter, contact Simpson Electric Co.)

5.8 ZERO ADJUSTMENT

5.8.1 Turn on instrument and allow 15 minutes for warm-up.

CAUTION!

Do not turn instrument on without either the Main Amplifier or the Main Amplifier Load Adapter in place in the instrument.

5.8.2 Turn potentiometer R5, located on LP7 (see Figure 5-2), fully CW. Momentarily apply a voltage of approximately 1V to contacts "a" and "b" of the Load Adapter (positive polarity on "a"). The readout should indicate a negative value. Short contacts "a" and "b" together, the readout should indicate between −0.01 and −0.05. Turn potentiometer R5, located on LP7 (see Figure 5-2) CCW until the reading changes from −0.01 to −0.00.

5.8.3 Remove the short between contacts "a" and "b", and momentarily apply a voltage of approximately 1V to contacts "a" and "b" (negative polarity on "b"). The readout should indicate a positive value. Short contacts "a" and "b" together and slowly turn potentiometer R8 located on LP1 (see Figure 5-2), until readout indication changes from +0.01 to +0.00.

5.8.4 Check zero adjustment by alternately applying voltage to and shorting contacts "a" and "b" as in paragraphs 5-16 and 5-17. The readout should change from −0.00 to +0.00 as the input polarity is changed.

5.9 REFERENCE ADJUSTMENT

5.9.1 Remove the short between contacts "a" and "b" and apply 2.786 Volts from the Calibrator using the DVM to monitor the voltage.

5.9.2 Adjust potentiometer R6, located on LP8 (see Figure 5-5), until readout indicated −198 and continue turning R6 in the same direction until the readout indicated −199.

5.9.3 Reduce the calibration voltage until the readout indication changes to −198 and then increase the calibration voltage until the readout indication returns to −199 noting the calibration voltage limits. The calibration voltage limits should fall between 2.783 and 2.789 volts. If the calibration voltage exceeds the limits repeat the adjustment in paragraph 5.9.2.

5.9.4 Increase the calibration voltage to 10.252 volts and adjust potentiometer R3, located on LP8 (see Figure 5-5), until readout indicates −733 and continue turning R3 until the readout indicates −734.

5.9.5 Reduce the calibration voltage until the readout indication changes to −733 and then increase the calibration voltage until the readout indication returns to −734 noting the calibration voltage limits. The voltage limits are 10.252 to 10.274 and if the calibration voltage exceeds these limits repeat the adjustment in paragraph 5.9.2.

5.9.6 Turn off the Model 2701 and remove the load adapter and replace the main amplifier. Connect the main amplifier ground terminal to the Chassis.

5.10 RANGE CALIBRATION

5.10.1 Short all inputs and turn the instrument on allowing 15 minutes for warm-up.

5.10.2 Switch in the mV D.C. range and adjust potentiometer R119, located on LP26 (see Figure 5-5), until −0.00 or +0.00 is indicated by the readout. Switch in consecutively all D.C. voltage and D.C. current ranges. The readout must indicate less than 9 counts in the Ω range, and 0.00 or 0.01 in the KΩ and MegΩ ranges.

5.10.3 Switch in consecutively all A.C. current and A.C. voltage ranges. The readout, in the "mA" range, should indicate less than 10 counts and in the "mV" and "V" ranges the indication should be less than 30 counts. If the readout indication is higher than that listed above, replace the main amplifier.

5.10.4 Remove the shorts from the inputs and switch to the "mV" range. Apply −8.880 mV from the calibration standard and adjust potentiometer R140, located on LP2C (see Figure 5-5), for a readout indication of −8.88.

5.10.5 Reduce the calibration voltage until readout indicates −8.87 and then increase the voltage until the readout indication returns to −8.88 noting the calibration voltage limits. The voltage limits should fall between 8.876 and 8.884. If the calibration voltage exceeds the limits repeat the adjustment in paragraph 5.90.

5.10.6 The remaining calibration steps are to be performed according to Table 5-2.

TABLE 5-1 RECOMMENDED TEST EQUIPMENT

Instrument Type	Purpose	Required Characteristics	Recommended Model
Calibrator	Performance Check Calibration	Range: A.C. & D.C. Voltage −0 to 1000V A.C. & D.C. Current −0 −10A Accuracy: D.C. ±0.2% plus 1 digit A.C. ±0.4% plus 1 digit	HP Model 692CB
A.C.-D.C. Digital Voltmeter	Performance Check Calibration	Range: 0-1000V Accuracy: ±0.1% or greater	DANA Model 5500/130 with A.C. Converter
80MΩ Resistance	Calibration	Accuracy: ±1%	Simpson No. 1-113353

TABLE 5-2 CALIBRATION ADJUSTMENT CHART

Adjustment Step	Range	Input	Potentiometer Number	Potentiometer Location*	Model 2701 Readout
1	mV DC	−8.880mV	R140	Lp2	−8.88mV
2	mV DC	−888.0mV	R39	Lp9	−888mV
3	mV DC	−88.80mV	R38	Lp9	−88.8mV
4	V DC	−8.880V	R1	Lp12	−8.88V
5	V DC	+8.880V	R22	Lp1	+8.88V
6	V DC	−88.80V	R5	Lp12	−88.8V
7	mA DC	−8.880mA	R5	Lp11	−8.88mA
8	nA DC	−888.0nA	R14	Lp11	−888nA
9	Ω	82.0Ω	R21	Lp12	83.0Ω
10	KΩ	820.0KΩ	R14	Lp12	820KΩ
11	KΩ	8.200KΩ	R15	Lp12	8.20KΩ
12	MΩ	80.00MΩ	R17	Lp12	80.0MΩ
13	MΩ	8.200MΩ	R19	Lp12	8.20MΩ
14	mV AC	888.0mV	R1	Lp1	888mV
15	V AC	8.880V	R40	Lp9	8.88V
16	nA AC	888.0nA	R2	Lp11	888nA

*See Figures 5-2 through 5-6.

TABLE 5-3 POWER SUPPLY SPECIFICATIONS

Power Supply (LP 13) Voltage Outputs

D.C. Voltage*	A.C. Ripple	Connector Pin No.
+250V nom.	8V p-p	1
+ 80V nom.	2V p-p	2
+ 24V nom.	1V p-p	3
− 24V nom.	1V p-p	5
− 80V nom.	2V p-p	7
Reference	— — —	4

*(@ 117 VAC 50/60 Hz)

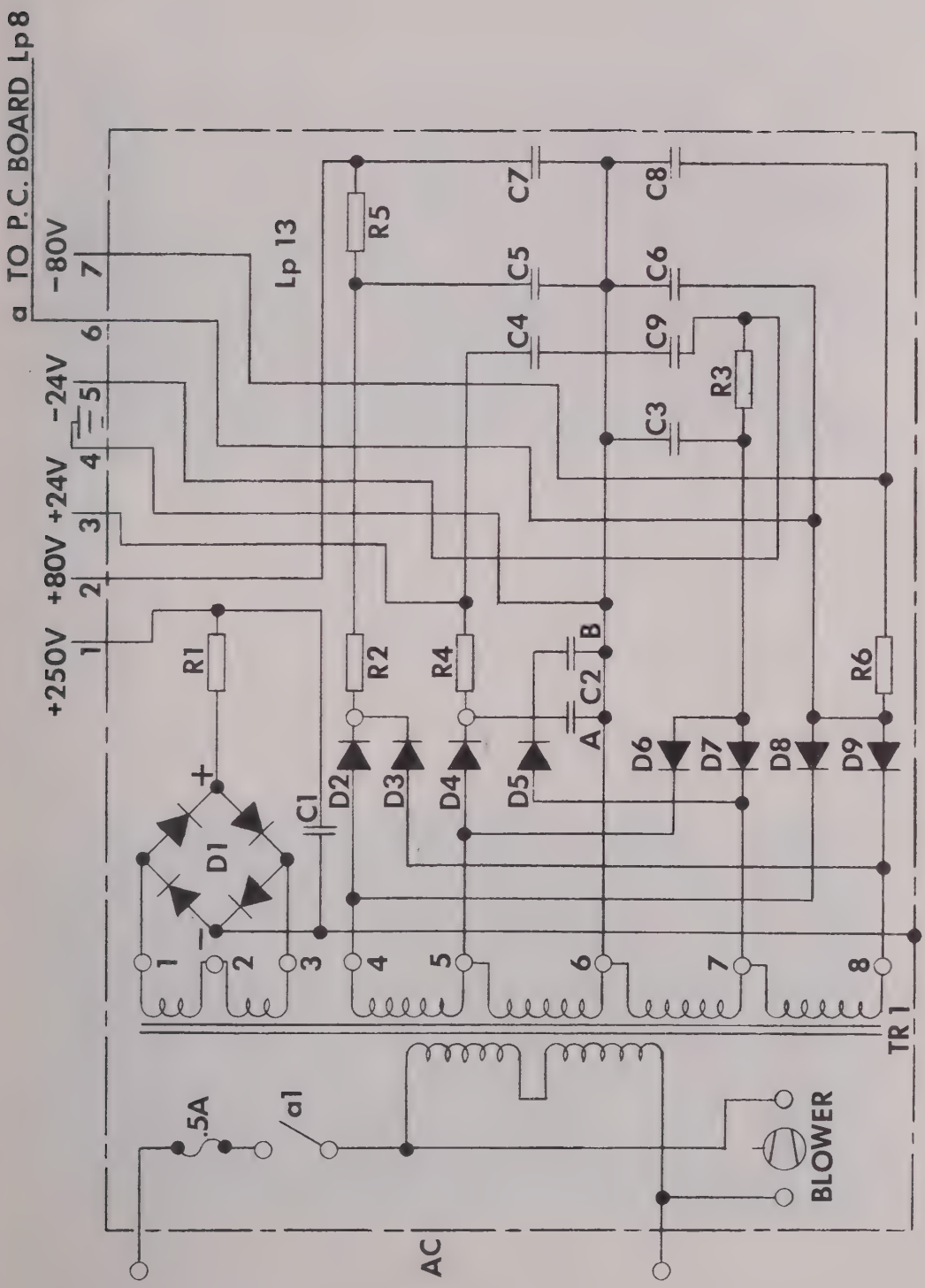


FIGURE 5-1 POWER SUPPLY SCHEMATIC

SIMPSON INSTRUMENTATION PRODUCTS MODEL 270I

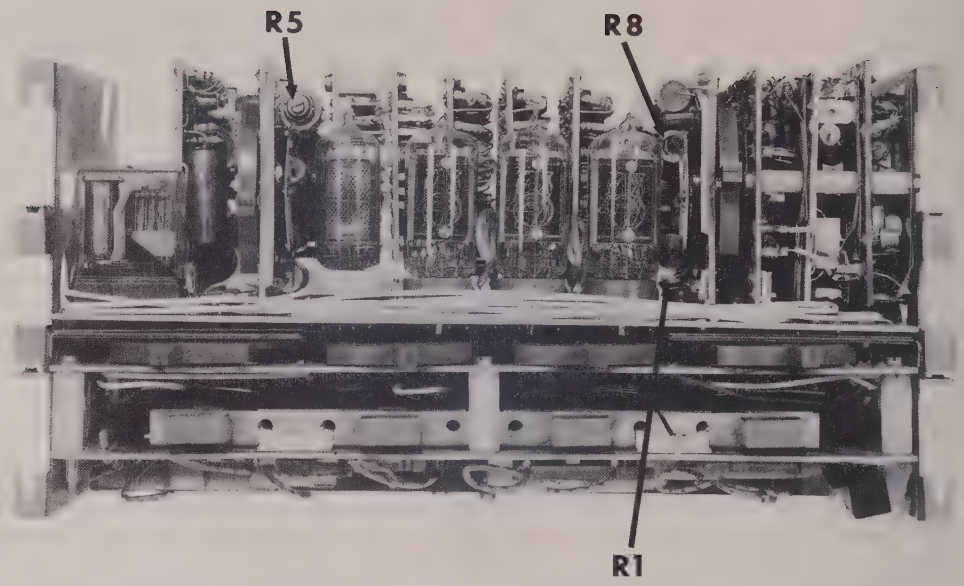


FIGURE 5-2 CONTROL LOCATION (FRONT)

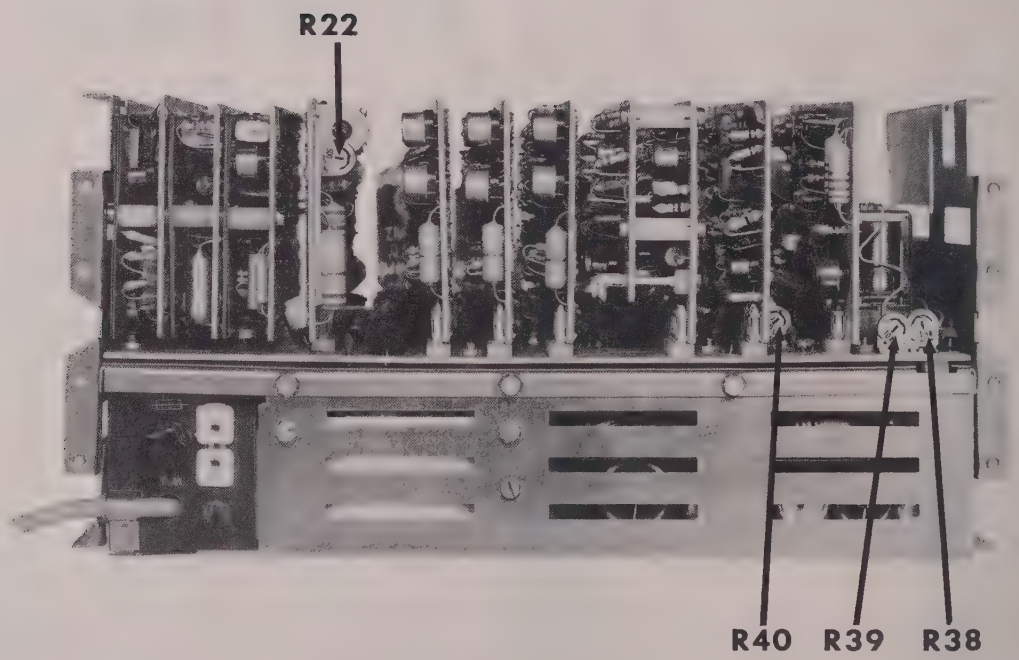


FIGURE 5-3 CONTROL LOCATION (REAR)

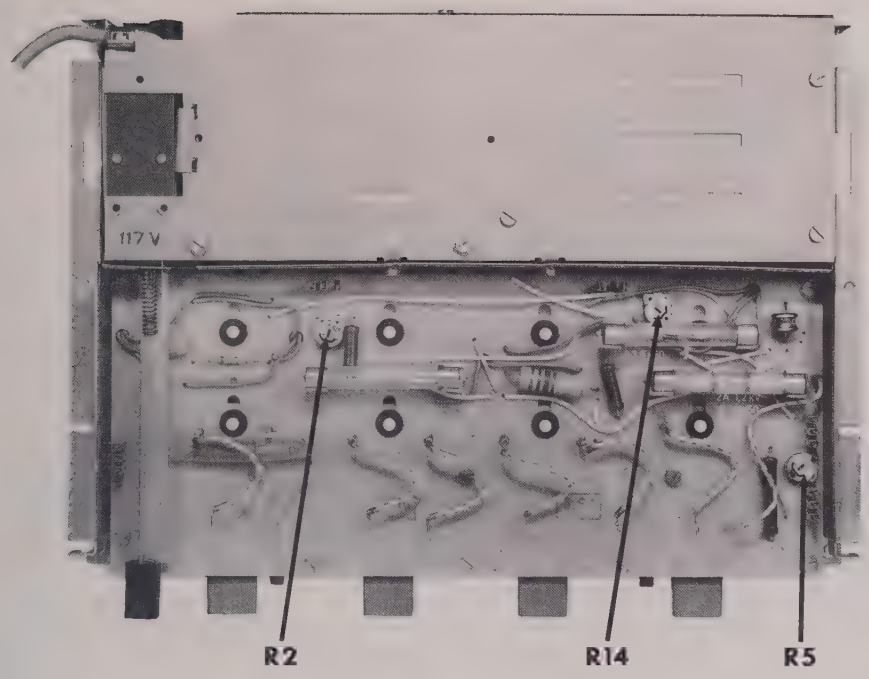


FIGURE 5-4 CONTROL LOCATION (BOTTOM)

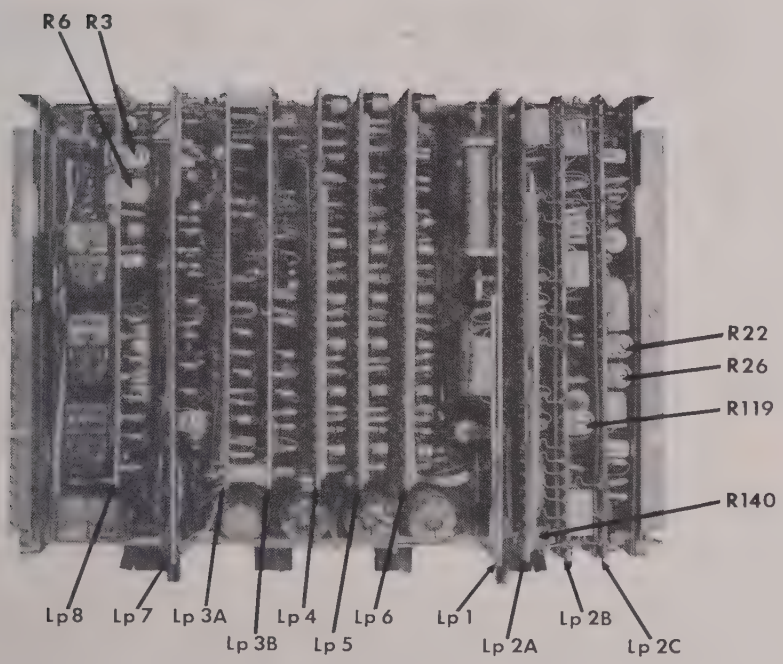


FIGURE 5-5 CONTROL LOCATION (TOP)

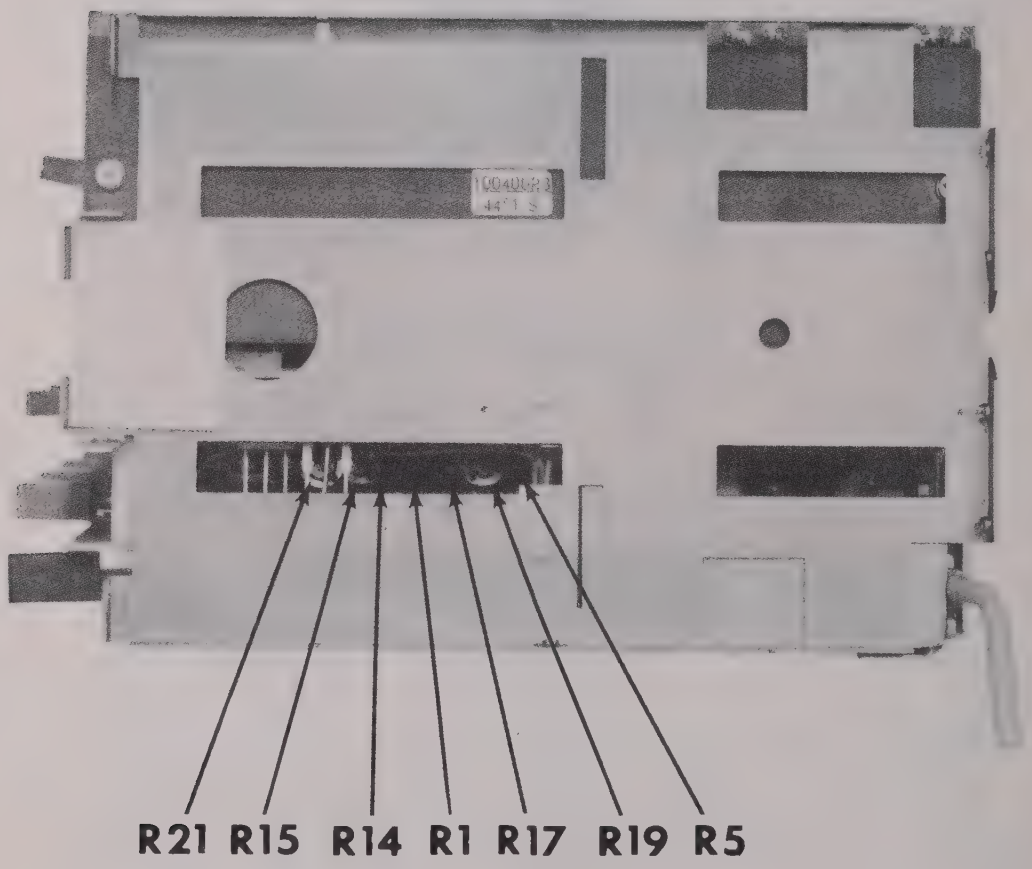


FIGURE 5-6 CONTROL LOCATION (RIGHT SIDE)

5.11 TROUBLESHOOTING

5.11.1 No visual indication when unit is turned on.

a. Check A.C. power source, line cord and plug.

b. Check fuse in transformer primary. (To replace fuse see Section 5-4 Case Removal)

NOTE:
Power supply may be removed by removing five (5) fasterners, disconnect the power switch, unplug line cord, move the supply down and outward.

c. Check for any burnt spots around the transformer, diodes and resistors.

d. If the power supply delivers voltages as indicated on the schematic, then check for a bad connection between the supply and the main chassis.

5.11.2 Lamps flicker, readout fuzzy, brightness levels dissimilar.

a. Check power supply function.

b. Check voltage regulator on LP8—input to be between —75V and —85V, outputs —60V and —61V.

c. Check contacts for solid connection.

d. Zero reset on the Comparator Amplifier, LP7, defective or intermittent. Read incoming voltages to this stage as per Figure 4-5B.

e. Narrow down the flickering as follows:
For the 100 decade, check LP4, for the 10 decade, check LP5, and for the unit decade check LP6.

5.11.3 Certain digits not indicated.
(Example: Indication of even or odd digits, only).

a. Exchange indicator tubes.

b. Check sockets and circuit boards for shorts or poor contacts.

c. Check voltages on the counter module affected.

5.11.4 Readout holds after input removal.

a. Check supply voltage to the Comparator Amplifier, LP7.

5.11.5 Numerical Readout doesn't reach maximum.

a. Exchange readout tubes mutually, check wiring to the sockets.

b. Check LP4, LP5 and LP6.

5.11.6 Oscillating or Unstable.

a. Check zero point setting for the Comparator Amplifier, LP7.

5.11.7 Polarity sign, + or — only.

a. Check voltages to the Logic Module LP3.

b. Check voltages to the Inverter Amplifier LP1.

c. Check for +24 volts to be supplied to the relay on LP1.

d. Check voltages to LP7, the Comparator Amplifier.

5.11.8 Decimal Point Switching Defective.

a. Relay switching is audible, decimal lamp dark,—replace lamp.

b. Base plate inspected to see if power supply voltages are reaching lamp circuits.

c. Check Logic circuit LP3.

5.11.9 Relays Inoperative.

a. Check each to ascertain that +24 VDC is reaching the relay coils.

b. If the relays are being energized but no decimal point switching takes place, check back to the Logic circuit LP3.

5.11.10 Turn on effect.

a. Turn on and press switch for volts or amperes. Counter should start counting for about 1 second, then reset to "0.00".

b. If a 1 appears on the readout, recheck zero setting for the Comparator Amplifier LP7.

5.11.11 Readout does not stop.

a. Insert Main Amplifier Load Adapter test unit in place of the main amplifier. Short input terminals to the test unit.

b. If still defective check voltage at the anode of diode D3 or point 1/11 on LP1. See Figure 4-2B. The voltage should be zero, otherwise LP1 is defective. Check supply voltages to LP1.

c. Remove dummy test unit, insert the main amplifier and check supply voltages to it.

d. The switching assembly may be defective. Intermittent contacts or open contacts.

e. Check for an open circuit in the negative feedback loop of the main amplifier.

5.11.12 Readout "0.00" when metering should take place.

a. Check input circuitry, main amplifier and the A/D converter.

b. If the A/D converter appears to have a problem, exchange LP1, LP7, LP6, LP2 in that order.

c. Partial zero readout may indicate that one range only has a blown fuse.

5.11.13 Unstable Readout.

a. Check with "filter" in and a constant input signal.

b. Check LP8 to determine that —60V regulated is in proper order. (Test with Main Amplifier Load Adapter test unit in place of main amplifier.)

c. Impedance changer, LP8, to be checked for proper operation.

5.12 REPLACEABLE PARTS

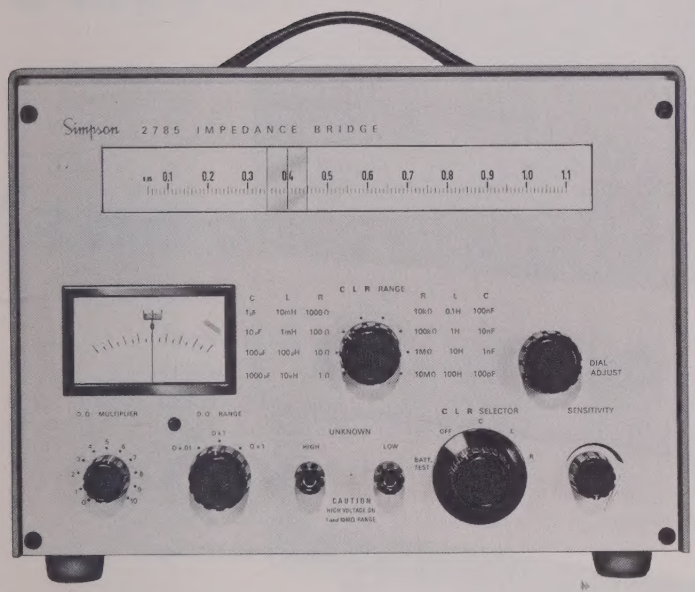
Description	Part Number
View Plate, Red	BR-0-00001
Front Closing, Panel Mounting Plate	BR-0-00002
Base Plate	BR-0-00003
Switch Assembly Complete	BR-0-00004
Power Switch Shaft	BR-0-00005
Bezel (Front Frame)	BR-0-00006
Front Panel	BR-0-00007
Power Supply Assembly Complete	BR-0-00008
Nylon Fastener Strip	BR-0-00009
Case Assembly with Handle	BR-0-00010
Back Plate and Blower Assembly (117 Volt)	BR-0-00011
Readout Tube (ZM 1032)	BR-0-00012
Polarity Indicator Tube (ZM 1133)	BR-0-00013
Polarity Sign Relay (K4)	BR-0-00014
Relay (K1 and K3)	BR-0-00015
Relay (K2)	BR-0-00016
Bakelite Retainer Strap	BR-0-00017
Top Retainer Plate	BR-0-00018
Impedance Converter and Voltage Regulator P.C. Board (LP8)	BR-0-00019
Comparator Amplifier P.C. Board (LP7)	BR-0-00020
Logic P.C. Board (LP3)	BR-0-00021
Counter P.C. Board, Hundreds (LP4)	BR-0-00022
Counter P.C. Board, Tens (LP5)	BR-0-00023
Counter P.C. Board, Ones (LP6)	BR-0-00024
Inverter Amplifier P.C. Board (LP1)	BR-0-00025
Main Amplifier P.C. Board (LP2)	BR-0-00026
Decimal Point Lamp	BR-0-00027
Base Ground P.C. Board (LP9)	BR-0-00028
Fuse, 2 Amp., 1.2KV	BR-0-00029
Fuse, 10mA, 1.2KV	BR-0-00030
Fuse, 100mA, 1.2KV	BR-0-00031
Fuse, .5A, 250V	BR-0-00032

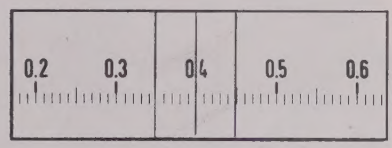
Simpson
INSTRUMENTATION PRODUCTS

PRECISION R-L-C BRIDGE

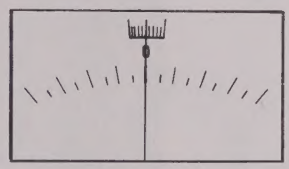
SELF-CONTAINED, WITH EASY-TO-USE CONTROLS

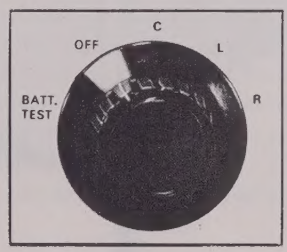
model 2785





EASY READOUT





SIMPLE OPERATION

■ **FAST—EASY-TO-USE**

No critical adjustments. Meter "null" indications are smooth and accurate. For capacitance and inductance measurements, the operator simply sets the range switch to the approximate value and adjusts the slide-rule dial until the meter nulls.

■ **MEASURES CAPACITANCE, INDUCTANCE, RESISTANCE, AND "Q"**

All with one compact battery operated unit less than 9″ high. Switch selection of functions is made with a front panel control.

■ **BUILT-IN 1 kHz OSCILLATOR**

Makes measurements at the accepted standard frequency of 1,000 Hertz. Provision has been made for an external oscillator to allow measurements at other frequencies.

■ **ACCURATE**

The 2785 is accurate to within ±1% on most Resistance and Capacitance ranges, to within ±1.5% on most Inductance ranges. "Q" measurements have a maximum error of ±5%.

DESCRIPTION

Simpson's new model 2785 is a precision multi-purpose bridge for measuring capacitance, inductance, resistance, and "Q". Powered by two long-life 9-volt batteries, a built-in generator provides all the voltages needed for the 2785's wide range of measurements. The generator operates at the standard test frequency of 1 kHz. For testing components at other frequencies, an external voltage input jack is provided. DC is used for all resistance measurements, with the voltage directly from the batteries, or rectified from the generator for those ranges requiring higher voltages. Even with its wide-range versatility, the 2785's long slide-rule dial and sensitive galvonometer make it simple and fast to use. Available for "off the shelf" delivery at electronic distributors stocking Simpson Instrumentation Products.

SIMPSON ELECTRIC COMPANY

5200 W. Kinzie Street, Chicago, Illinois 60644 • Phone (312) 379-1121

AGM DIVISION

SIMPSON INSTRUMENTATION PRODUCTS MODEL 2701

Simpson
INSTRUMENTATION PRODUCTS

NEW

DIGITAL SYSTEM with INTEGRATED CIRCUITS

MODEL 2700

- INTEGRATED CIRCUIT COMPACTNESS AND RELIABILITY
- ACCURACY WITHIN ±0.05%, ±1 DIGIT
- FULLY AUTOMATIC POLARITY SELECTION, WITH INDICATION
- 4 FULL TIME DIGITS, PLUS 10% LINEAR OVERRANGE
- FAST: UP TO 5 NEW READINGS PER SECOND

New Simpson 2700 digital system has an outstanding combination of features. Basic unit has four DC voltage ranges, capable of precise measurements from .0001 to 999.9 volts. Plug-in units are available for DC current, AC voltage, and resistance measurements. Convenience features include push-button front panel calibration check and automatic polarity selection (with indication). The 2700 weighs just 8 ibs., and is only 4 inches high, 8¼ inches wide. Its components and well-engineered design assure reliability. . . . I/Cs, FET input, and 200,000 hour readout lights.

OPTIONS

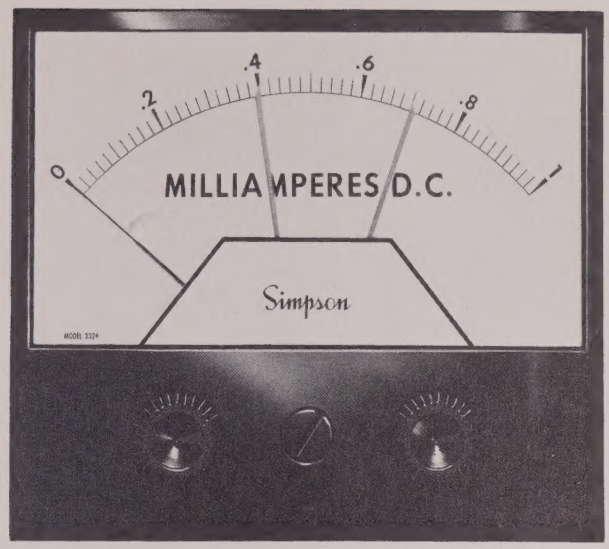
In addition to plug-in units for current, resistance, AC voltage, and capacitance measurements, the 2700 digital system is available with:

- 4 line BCD output
- Rack mounting
- External sample command

SIMPSON ELECTRIC COMPANY 5200 WEST KINZIE STREET, CHICAGO, ILLINOIS 60644 • AREA CODE 312, 379-1121

©COPYRIGHT SIMPSON ELECTRIC CO.

Simpson controllers



Maximum reliability design ...

Intended for control, alarm, and limit applications—with utmost dependability. Photoconductor sensing eliminates all interference with the indicating meter. High gain transistor switch circuit provides solid state reliability, accurate switching, and extremely small dead band. Control points are adjusted from the front panel thru a gear drive. The solid-state switching circuit triggers internal DPDT relays with 10-ampere contacts (one relay for each control point). Ideal for unattended operation, they can be obtained *from stock* in a wide selection of ranges, with either dual or single control points, and in three sizes.

CONTACTLESS

Sensing is accomplished with a photoconductor and infinite life lamp. By using light beams instead of contacts, the meter accuracy is completely unimpaired.

HIGH SENSITIVITY

Taut Band meters are available for operation on very small power—10μA @ 4,900 Ω available.

FAIL SAFE CIRCUITRY

These meter relays are designed for unattended operation. The internal slave relays are capable of switching 20 ampere 115 volt (resistive) loads. In the event of a power failure, these relays automatically "open".

RUGGED SEAL CONSTRUCTION

Completely sealed, with metal case and thick glass window, these meter relays will withstand rigorous environmental conditions. Shielded—they are not affected by panel mounting or stray magnetic fields.

EXTREMELY SMALL DEAD BAND

The difference between "on" and "off", with the measured value increasing or decreasing, is within 0.5% of full scale.

Get "off the shelf" delivery from your local electronic distributor.

SIMPSON ELECTRIC COMPANY
5200 W. Kinzie Street, Chicago, Illinois 60644 • Phone (312) 379-1121
Export Dept: 400 W. Madison Street, Chicago, Illinois 60606, Cable Simelco
IN CANADA: Bach-Simpson Ltd., London, Ontario
IN INDIA: Ruttonsha-Simpson Private Ltd., International House, Bombay-Agra Road, Vikhroli, Bombay

AGM DIVISION

SIMPSON INSTRUMENTATION PRODUCTS MODEL 2701

SALES-SERVICE CENTERS

MODIFICATION, CUSTOMER REPAIR AND PARTS SALES

CALIFORNIA, LOS ANGELES 90022
Metermaster, Inc.
5646 Jillson Street
Tel. (213) 685-4340

GEORGIA, HAPEVILLE 30054
Brownell-Electro Inc.
P.O. Box 82760
Tel. (404) 762-5181

ILLINOIS CHICAGO 60644
Simpson Electric Co.
5200 W. Kinzie St.
Tel. (312) 379-1121

MASSACHUSETTS, BURLINGTON 01803
The Mancib Company
Middlesex Turnpike at "A"
Tel. (617) 272-9450

MICHIGAN, FERNDALE 48220
Ram Meter, Inc.
1100 Hilton Road
Tel. (313) 547-1000

NEW YORK, NEW YORK 10013
Nilsson Electronic Labs
103 Lafayette Street
Tel. (212) WA5-1730

OHIO, CLEVELAND 44105
Pioneer/Cleveland Instrument Lab.
Div. of Pioneer Standard Electronics Inc.
4800 East 131 Street
216–587–3600

PENNSYLVANIA, PHILADELPHIA 19115
Sunshine Scientific Instrument
1810 Grant Avenue
Tel. (215) 673–5600

TEXAS, HOUSTON 77006
Electrical Instrument and Meter Company Inc.
1602 Missouri
713/526-6871 - 6872

SIMPSON ELECTRIC COMPANY
5200 West Kinzie Street, Chicago, Illinois 60644 / Phone (312) 379-1121 / TWX (312) 896-5391 / TELEX 02-53343